RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #4

UAT Performance in the Presence of Operational Link 16 Interference Scenarios

Prepared by Warren J. Wilson and Myron Leiter

The MITRE Corp.

SUMMARY

In partial fulfillment of Action Item 3-13, this paper addresses the performance of the various UAT burst types in the presence of the Link 16 interference environments described in working paper UAT-WP-3-08.

1. Introduction

At meeting #3 of Working Group 5, a set of three different Link 16 interference scenarios were provided in working paper UAT-WP-3-08. In each of these scenarios, there is a background environment of three 100% time slot duty factor (TSDF) nets with a received signal level of –84.5 dBm at the victim UAT receiver. The foreground levels of the three different scenarios are based on one 100% TSDF net loaded as follows:

Option (a): 50% at –60 dBm and 50% at –50 dBm
Option (b): 50% at –60 dBm and 50% at –39 dBm
Option (c): 50% at –60 dBm, 20% at –39 dBm and 30% at –50 dBm.

Note that in each of these options there are exactly four Link 16 transmitters occupying each time slot, transmitting 258 pulses per slot. The only difference between the different options is the mix of received power levels. Option (a) is the "easiest" environment, option (b) is the "hardest," and option (c) is in between.

In the graphs below, we show the performance of the various types of UAT messages versus the three scenario options. Only Link 16 interference has been included. UAT self-interference and DME interference can be added later.

The properties of the Link 16 interferers are identical to those assumed in working paper UAT-WP-2-03, except for the power levels. The victim UAT receiver is also modeled as in UAT-WP-2-03, except for the following changes:

- The coding of the long ADS-B message is assumed to be RS(45,33) or RS(47,33) with no CRC.
- The coding of the short ADS-B message is assumed to be RS(27,17) or RS(29,17) with no CRC.
- The transmitted power (ERP) of the ADS-B messages is either 5 watts, 12.5 watts, or 100 watts.
- The receiver IF filter is assumed to be the narrow filter (referred to as the "700 kHz" filter) discussed in working paper UAT-WP-03-02. A graph of the presumed frequency response of this filter is shown below in figure 1.

The operating frequency of UAT is assumed to be still at 981 MHz. If the frequency is moved to 978 MHz the performance is expected to remain materially unchanged. If anything, the performance of UAT will be slightly better since the frequency is closer to the Link 16 band edge.

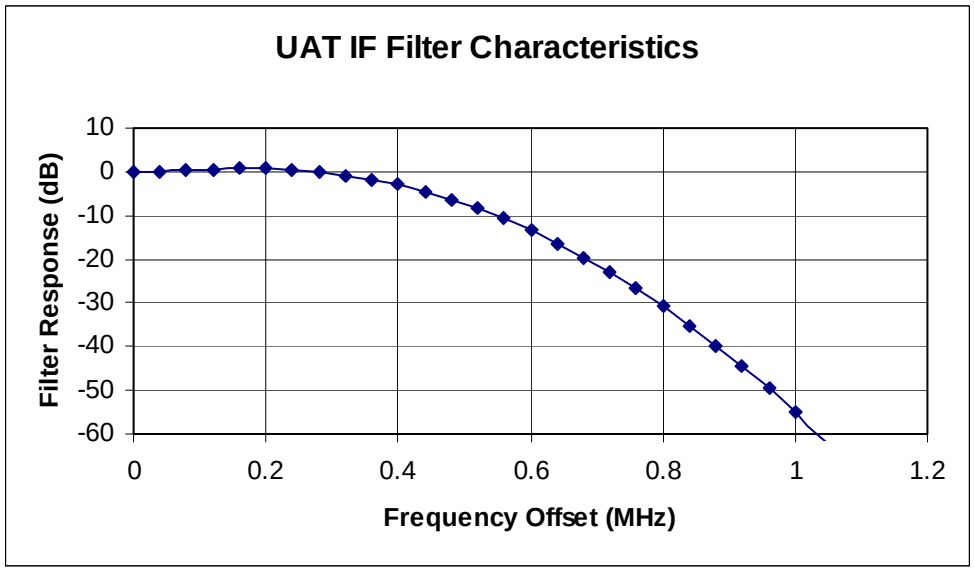

Figure 1. UAT IF Filter Response

2. Performance

The first performance graph (figure 2) shows the performance of the UAT up link message as a function of the UAT transmitter/receiver separation. The solid line shows the performance target (10% burst error probability) suggested in working paper UAT-WP-3-16. The results show that the up link ranges are all about 100 nmi or greater.

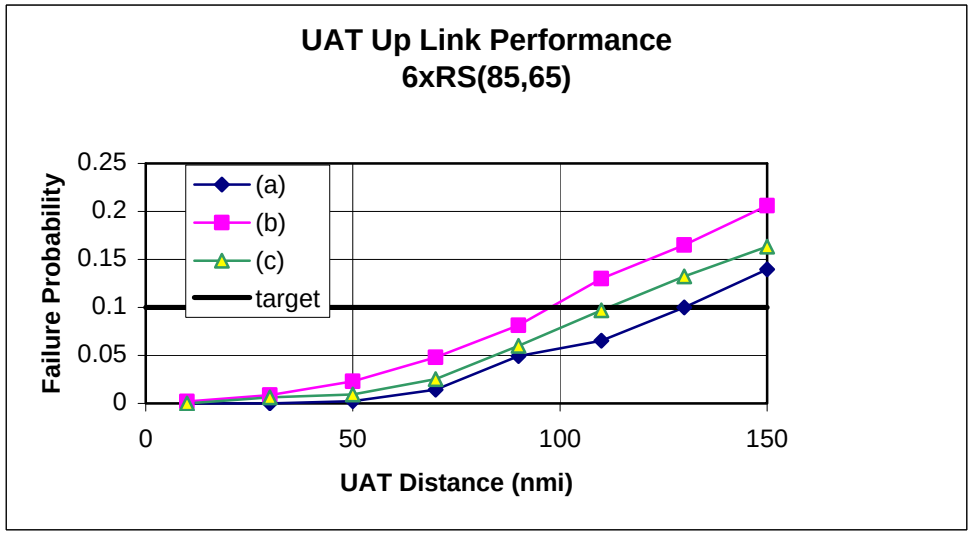

Figure 2. Up Link Message Performance. ERP = 125 Watts

The remaining graphs show the performance of the various choices for the long (figures 3 through 8) and the short (figures 9 through 14) ADS-B messages for the three power levels mentioned previously.

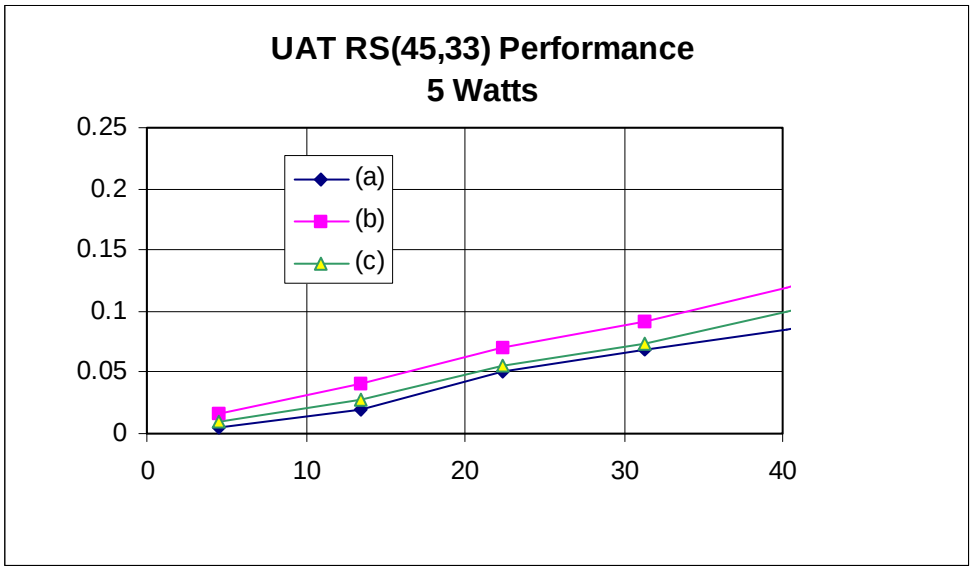

Figure 3. Long Message Performance @ 5 Watts

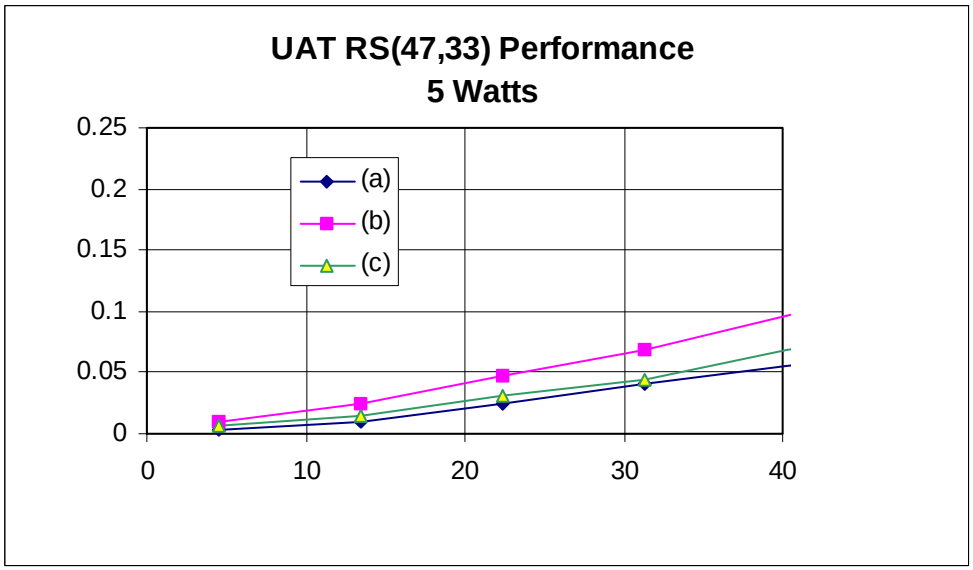

Figure 4. Long Message Performance @ 5 Watts

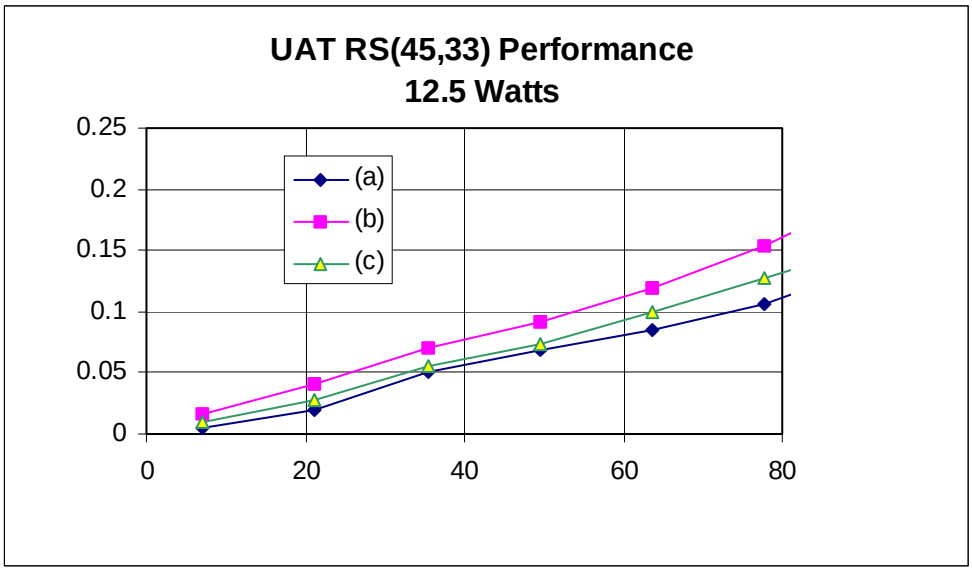

Figure 5. Long Message Performance @ 12.5 Watts

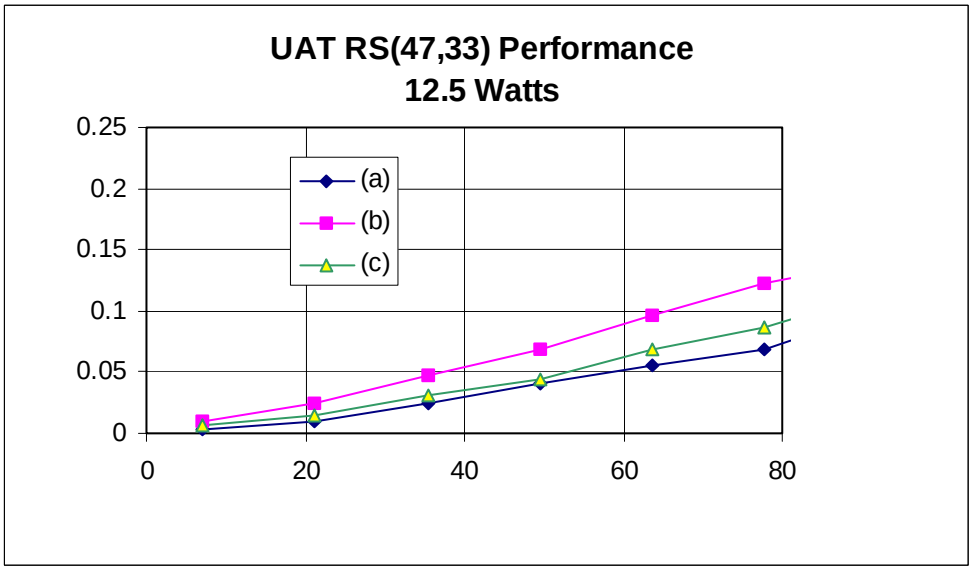

Figure 6. Long Message Performance @ 12.5 Watts

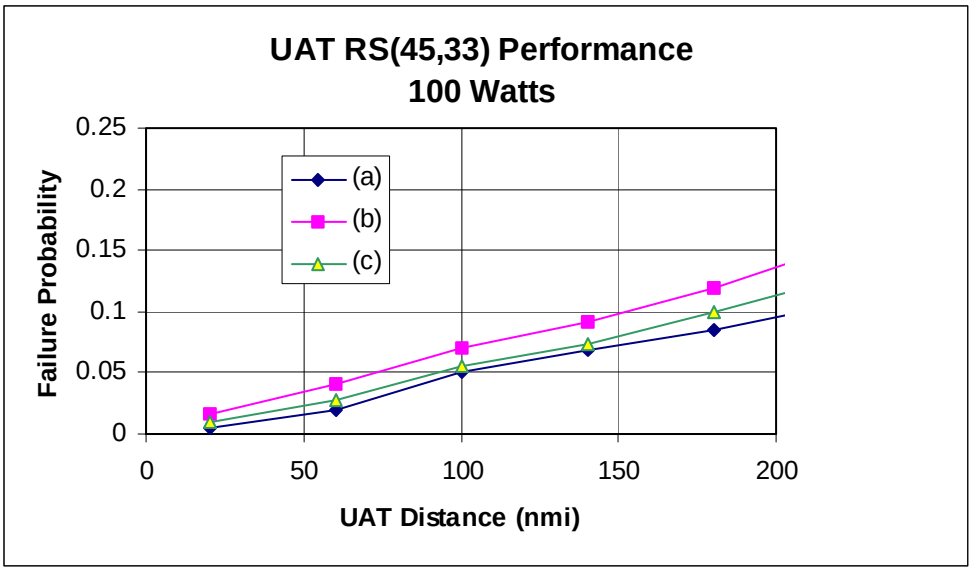

Figure 7. Long Message Performance @ 100 Watts

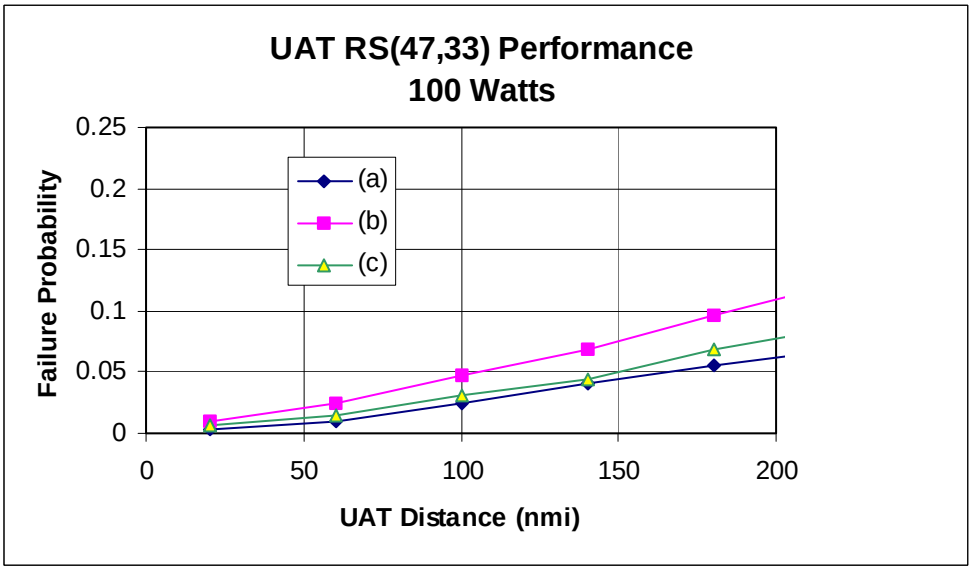

Figure 8. Long Message Performance @ 100 Watts

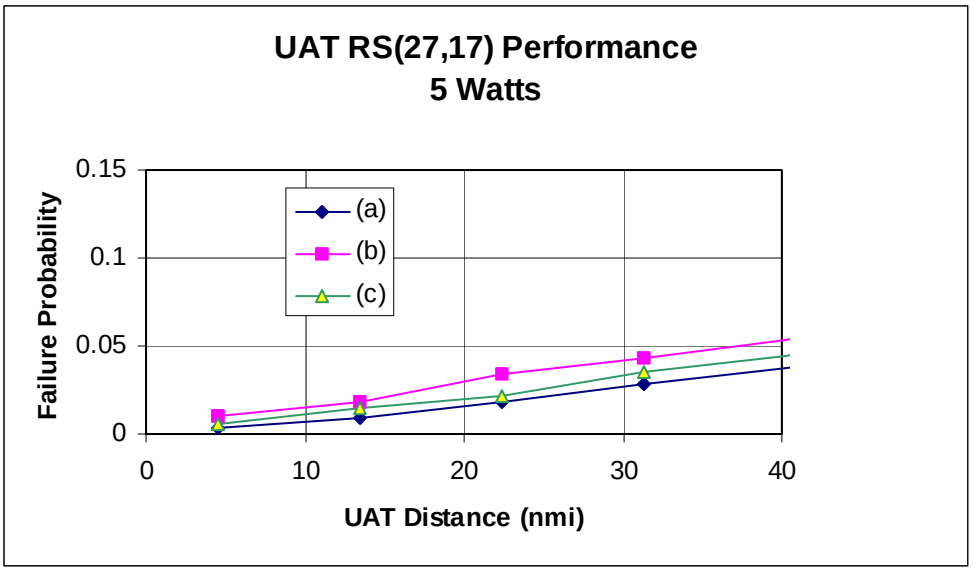

Figure 9. Short Message Performance @ 5 Watts

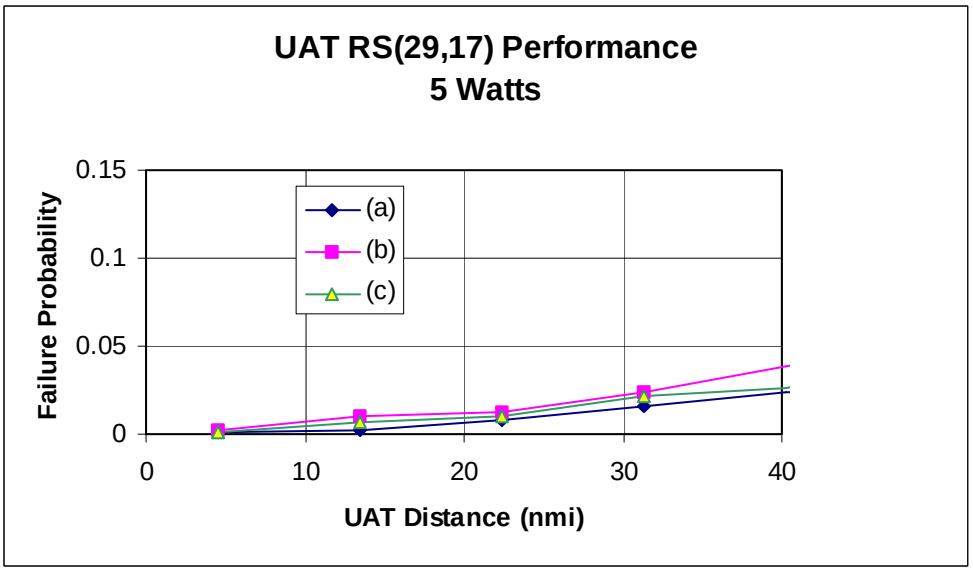

Figure 10. Short Message Performance @ 5 Watts

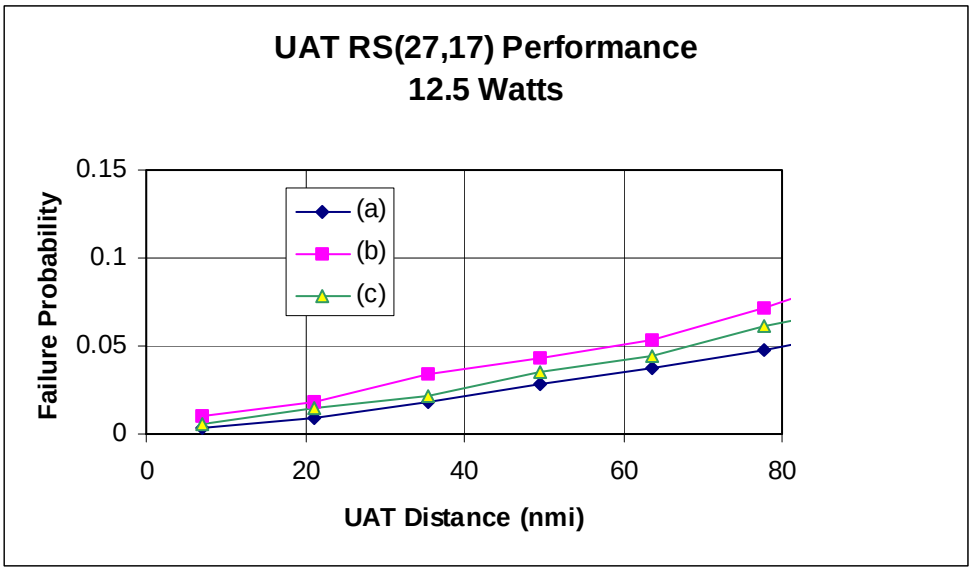

Figure 11. Short Message Performance @ 12.5 Watts

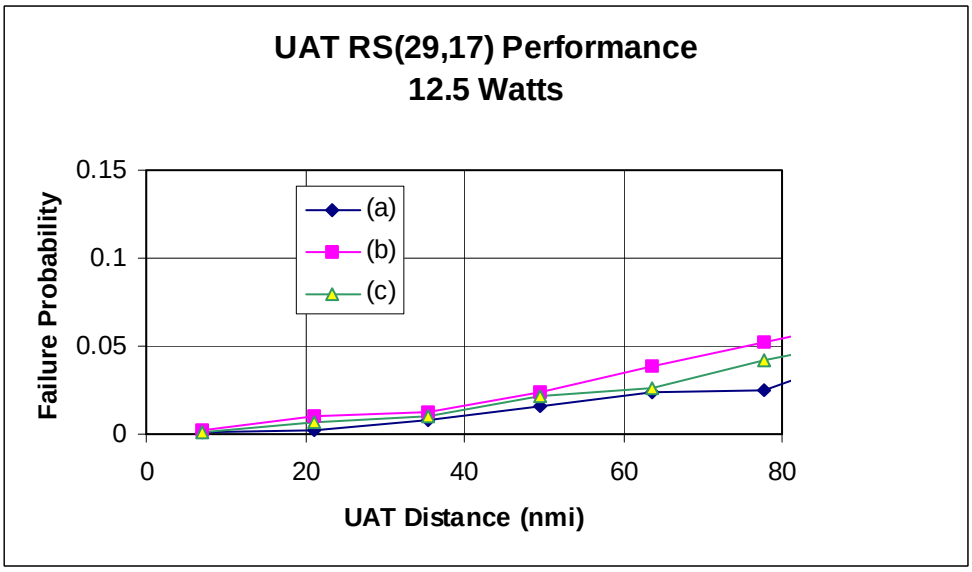

Figure 12. Short Message Performance @ 12.5 Watts

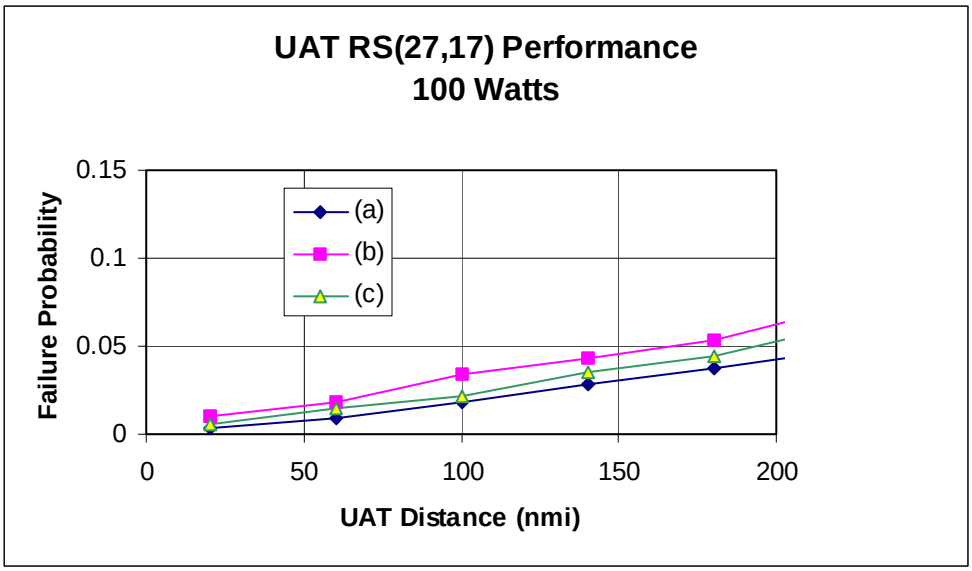

Figure 13. Short Message Performance @ 100 Watts

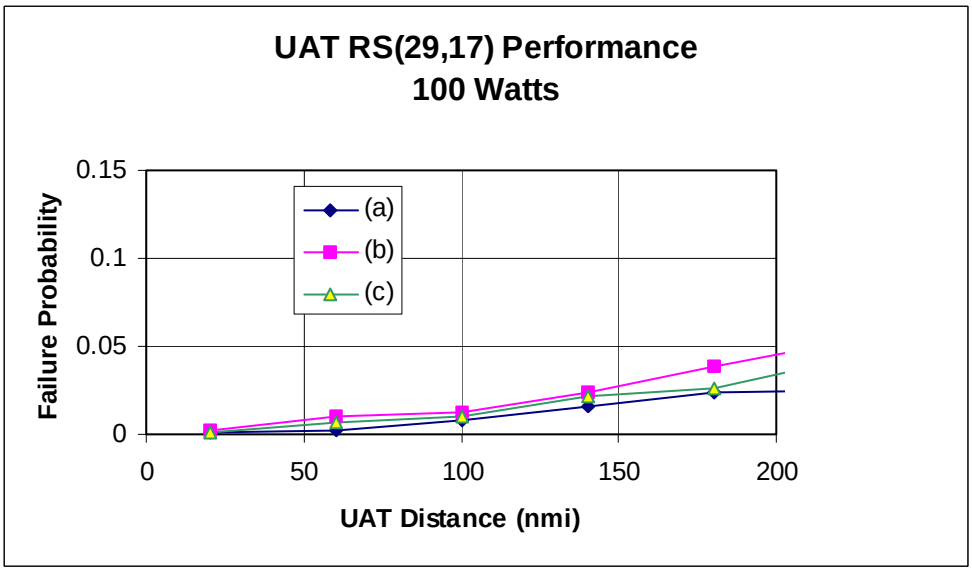

Figure 14. Short Message Performance @ 100 Watts

3. Summary and Conclusions

The performance graphs comprising figures 2 through 14 indicate that UAT is fairly robust in the prescribed Link 16 environments. All the proposed coding schemes seem adequate, with the ones with more parity bytes being clearly "stronger." It would be useful to add to each ADS-B curve a mask (similar to the solid line included in figure 2) representing the requirements. Concurrence on the correct locations of such masks would be very useful.

To complete the analysis of the up link message performance, DME interference should be added to the simulation (self-interference does not apply to this case). The nature of this interference could be determined by a worst-case analysis of the planned DME environment at whatever frequency is finally chosen for UAT. It also needs to be decided if the worst-case environments for Link 16 and DME can occur simultaneously, or if there is a somewhat reduced threat that needs to be confronted.

The ADS-B messages can experience Link 16 interference, DME interference, *and* self-interference simultaneously. Working Group 5 needs to determine one or more interference scenarios combining all these interference sources.

The simulation program from which the results in this paper are derived can easily be modified to include statistical models of the additional interference sources.

4. Recommendation

It is recommended that Working Group 5 consider the information in this paper in its deliberations on the UAT MOPS.